The figure-of-8 through-and-through monofilament abdominal wound closure with wound splints: Elimination of evisceration in poor-risk wounds over 25 years

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The method of through-and-through abdominal wall closure for poor-risk wounds reported in 1953 has been re-evaluated after 18 more years of use. It has proved in our experience the only method entirely free of postclosure evisceration and has been uncomplicated by significant or chronic suppuration, skin cutting and resultant postoperative pain, or intestinal fistulization. Success appears attributable to mechanically secure approximation without strangulation, elimination of dead space in the wound, and minimization of foreign suture material in the line of approximation.

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CLEAN SOUND HEALING of the abdominal wall after intra-abdominal operative procedures is a cardinal index of good surgical care.

The technical factors involved in successful wound healing are many, but those of especially accepted importance are: (1) minimization of bacterial contamination, (2) good hemostasis, (3) approximation without strangulation, (4) minimization of residual foreign material, (5) minimization of damage to tissues, and (6) obliteration of dead space.

The importance of obliteration of dead space was quantitated by Condie and Ferguson.[1] They deliberately contaminated abdominal wounds in dogs and found a space-obliterating pattern of closure to reduce the incidence of infection from 11 out of 12 in the conventionally closed wounds to 3 out of 12 in the experimental ones. Furthermore, they reported that monofilament closures were strikingly effective in reducing the infection rate as compared to closures with braided sutures of silk or Dacron. This is in agreement with the report of Elek and Conen[3] that the burial of silk sutures in man enhances the virulence of contaminating staphylococci by a factor of 10,000.

Cognizant of these principles but in advance of these specific studies, Dennis, Nelson, and Ankner[2] reported a method of closure in 1953 which was intended to approximate the fascial and muscle layers and skin, to bury a minimum of suture material at the line of approximation, to utilize a monofilament suture, and to obliterate the dead space in the wound.

Accepted for publication July 18, 1972.
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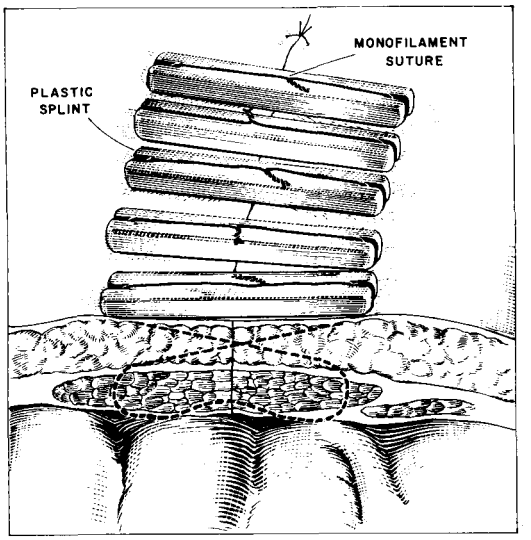

Fig. 1. Figure-of-8 through-and-through monofilament abdominal wall closure with wound splints.

METHOD

The details of the closure method are indicated in Fig. 1. This is a redrawing of the original illustration, redone for the purpose of emphasizing avoidance of bowstringing of suture material and thus the hazard of small bowel perforation therefrom.

Wound closure with figure-of-8 monofilament sutures and wound splints is now accomplished with 0.016 or 0.018 inch steel wire, or other inelastic monofilament suture of high tensile strength, such as No. 2 Tevdek.

When the time comes for closure, wound towels are removed and the skin about the wound is reprepared with antiseptic solution. Sutures are placed 2 cm. apart, first in the musculofascial structures 2 cm. back from the line of incision. In so doing, a bite of posterior fascia or rectus sheath and peritoneum is taken on each side (see Fig. 1). The large round Mayo needle used for this is removed, and hemostatic forceps are applied to the suture ends to permit progression of placement of sutures in this layer. Large trocar needles are now applied for passage of each end of each suture through the subcutaneous tissue and skin of the opposite side of the wound.

A length of wound splint is selected which is appropriate to approximate all layers without unduly pulling on the skin. Prior to drawing snug each of these sutures over the selected splint, the area between it and that just tied is explored with a finger, and, if necessary to avoid herniation between figure-of-8 sutures, a simple fine approximation suture of peritoneum and posterior fascia is placed and tied.

Snugging up the musculofascial layers and tying over the splints commonly completes the closure, although inaccuracies in placement occasionally must be corrected by three or four fine silk sutures or adhesive strips to approximate the skin precisely. In case the monofilament suture is steel wire of the diameters indicated, it is more convenient simply to twist the wires than to tie knots. This has proved entirely adequate.

Routinely, the fine accessory skin stitches or adhesive strips are removed in one week, and the figure-of-8 sutures and splints are removed 18 to 21 days after closure, longer if the patient has been on heavy steroid therapy, has low serum protein levels, has carcinomatosis, or has other reason to sug-

Table I. *Fate of closures employing figure-of-8 through-and-through sutures of No. 25 stainless steel with wound splints**

	No.
As supplement to standard closure:	
Uneventful sound healing	29
Infection followed by sound healing	4
Failure of healing of all wounds, with maintenance of closure by wires; death at one week	1
Wound normal at early death from cause other than wound	3
Total	37
As sole security of closure:	
Uneventful sound healing	14
Infection followed by sound healing	2
Dehiscence, cellulitis of abdominal wall, death at 2 months	1
Fecal fistula, carcinomatosis; bowel torn at operation, death late	1
Failure of healing, maintenance of closure by wires; death from other cause	2
Total	20
Grand total	57

*Reproduced with permission from Dennis, Nelson, and Ankner: Surg. Forum IV:. 601, 1953.

Table II. *Types of cases—Each closure incident listed but once*

	Patients	*Deaths*	*Remarks*
Crohn's disease or idiopathic ulcerative colitis	8	0	
Shock from gastrointestinal bleeding	5	2	Pneumonia in both, one after renal failure
Cancer with metastases or carcinomatosis	5	0	
Diabetes and/or obesity	6	1	Pancreatitis after gastrectomy
Peritonitis, pancreatitis, or pus in wound at time of closure	4	0	
Prednisone, more than 30 mg. per day	3	0	
Cancer in the senile	2	0	
Chronic biliary obstruction	2	0	
Suppurative cholangitis	2	0	
Intestinal obstruction with unrelieved distension	1	0	
Intestinal obstruction, carcinomatosis	1	1	Carcinomatosis, pulmonary emboli
Chronic cardiopulmonary insufficiency and hernia	1	0	
Hemolytic hypersplenism	1	1	Diffuse bleeding
Recent infection in reopened wound	1	0	
Diverticulitis and abscess, primary resection and anastomosis	1	0	
Wound dehiscences: Peritonitis, wound infection, and high intestinal fistula	1	1	High fistula
Diabetes and high steroids	1	1	Pulmonary embolus
Uncomplicated	1	0	

gest impairment of wound healing. Ordinarily this suture removal is done on an outpatient basis.

RESULTS

The authors have personally used or supervised use of this closure on 103 occasions. Of these, 57 are in the report of Dennis, Nelson, and Ankner[2] (Table I), and the remainder are from personal experience since 1953 (Tables II and III). The method has almost always been reserved for situations in which wound difficulty by conventional closure was considered highly likely.

The splint closure has proved reliable in the presence of severe distension in the early postoperative period (e.g., acquired adult megacolon), in the presence of violent thrashing about during recovery from anesthesia, and in the presence of massive steroid therapy associated with failure of other wounds to heal in the same patient.

The method has permitted the authors to proceed confidently despite such usually accepted contraindications as unexpected incision into abscesses on the way through the abdominal wall, most often on entering through old incisions. It has permitted closure of abdominal incisions made for drainage of intra-abdominal abscesses; here clean primary healing has been repeatedly observed in that portion closed with splints, limiting the area of secondary healing to that corner of the wound left open for egress of Penrose or tubular drains. It has permitted primary healing in explorations for purulent peritonitis as well. In these latter cases and in those with purulent intraperitoneal collections, it has been usual to lavage the abdomen for an hour with a dilute solution of broad-spectrum antibiotic in Ringer's solution, leaving an intravenous type of catheter through a puncture wound in the upper abdomen for continuing infusion of antibiotic, and a sump drain in a lower quadrant for evacuation.

Table III. *Fate of wounds closed with figure-of-8 monofilament sutures and wound splints*

	No.
No. of wound closures (not previously reported)	46
No. of eviscerations	0
Failure to heal, but apposition held by closure	1
Wound infection in clean expectancy wound	1
No. cleanly healed in face of visible contamination at time of closure	7
No. of late hernias	0

Finally, the splint method has been used in situations in which re-exploration of the abdomen has appeared in order within the first day or two after the original closure. Here simple untwisting of the wire and anchoring of the wire ends by hemostats has permitted such re-exploration more expeditiously and safely than by other methods. The wire sutures, already in place, are simply drawn snug again and twisted over wound splints for closure at the end of the re-exploration.

The fate of these closures is indicated in Table III.

COMMENT

The use of wound splints and monofilament figure-of-8 sutures for closure in situations of poor-risk wounds has been standard procedure at Kings County Hospital for 20 years and has been widely adopted in several of the other hospitals listed. A survey too inaccurate to justify attempts to quantitate indicates the number of such closures at Kings County Hospital and State University Hospital to have been in excess of 1,500. Review of the record books of all the surgical services reveals no instance of evisceration after such closure. Our Record Rooms' cross-listings unfortunately do not include the types of closure employed, and furthermore the Department of Hospitals of the City of New York has had the policy of destroying charts after seven years, so that these data are for the most part not retrievable.

The mechanical inadequacy of retention sutures without splints has been expounded by several authors, among them Price[6] and Taylor and Jontz.[7] This inadequacy is not significantly lessened by use of "booties" and is compounded by painful and unsightly cutting of the skin by the sutures.

The wound splint method described in 1953 has been adapted by Taylor and Jontz (1) to include a unit splint the length of the wound and (2) to avoid entry of the suture into the peritoneal cavity. The longitudinal splint was adopted because of a reported tendency under tension "to twist around longitudinally." We have been careful to place the full length of each of the figure-of-8 sutures in a plane perpendicular to the long axis of the wound, and suggest this as the reason for our failure to observe this difficulty.

As to fear of cutting bowel by bow-stringing intraperitoneal portions of the figure-of-8 sutures, Taylor and Jontz[7] report an instance, and we have seen an instance in totally buried wire closure in other hands elsewhere. We have not seen this complication in our own experience and observation with the splint closure nor has it come to light at Kings County Hospital or State University Hospital. We had nonetheless respected the possibility and chosen to catch the wound edges with the figure-of-8 suture in the mid-50's after seeing the tragedy noted above with totally buried steel sutures. We concur in the opinion of Taylor and Jontz that precautions should be taken but prefer passage through-and-through at the holding extremes of the suture loop because of the greater certainty of engaging the posterior rectus sheath or posterior fascia and taking advantage of the strength of these structures.

In 1963, 1964, and 1965 we studied variations in technique which might simplify the tedious closure as described. Polypropylene monofilament sutures were employed for a time*; the elasticity appeared to us, as an elastic closure had appeared to Taylor and Jontz, to be accompanied by rapid loosening and the need for frequent re-tying to maintain the desired tension. Surgaloy suture was employed in some cases, but too often became so anchored as to make removal impossible. We have seen no untoward effects from division of such anchored sutures under tension at skin level when withdrawal is impossible, but prefer to remove the figure-of-8 sutures altogether, and therefore do not use braided wire.

Reverdin needles were employed for a time. The procedure of closure was expedited, but the added trauma led to bleeding which in turn raised concern about the possibility of secondary infection. The same problem arises if cutting edge needles are employed. Use of a round Mayo needle is

*Kindly made available to us by Dr. Francis Usher.

straightforward except in the skin; the change to a trocar needle for the skin is time-consuming, but passage of the needle produces little bleeding and is expeditiously accomplished.*

The oaken splints reported in 1953 have been replaced by color-coded splints, of 5, 6, 7, and 8 cm. lengths, made of autoclavable plastic and which can be re-used if desired.†

The length of splint to use is based upon a balance of the estimated maximum momentary musculofascial pull of 7.5 Kg. per figure-of-8 suture and a suture pressure to be placed upon the splint sufficient to obliterate the subcutaneous dead space without cutaneous pain or skin necrosis. The actual dimensions employed suggest these momentary tensions to be well tolerated, and the pressures developed by the splint upon the skin during coughing or struggling during recovery from anesthesia leave no lasting ill effect. These pressures may be as much as 300 Gm. per square centimeter under the splint if the transit of the suture through the subcutaneous fatty and areolar tissue is three times the thickness of that layer. In practice, this is the ratio employed, although the splint is usually of the maximum length which does not impinge upon the groin or costal margin, or fail to conform to body curvature in small patients.

Placement of the suture through the subcutaneous tissue and skin must be thoughtfully accomplished to avoid necrosis-producing lateral pressure by the suture upon the friable areolar tissue. Choice of length of splint must consider the skin as well as the musculofascial tension already noted. In practice, the skin distance from suture exit to suture exit can be curtailed 25 percent by proper choice of length of splint. Greater curtailment leads to gradual skin cutting; this does not impair security of fascial closure, but it causes distress and leads to suppurative drainage from the suture exits. When this has occurred, the suture exits have healed quickly after removal of the sutures.

Uneasiness has been expressed by those new to the technique concerning the discomfort of removal of the wire sutures. If the wire is well cleansed and cut close to the skin while under traction so that the cut end is straight, the discomfort is rarely disturbing to the patient.

There are situations in which it is good practice to re-explore the abdomen within a day or two for security of determination of the viability of intestine left behind. Such is the case after reduction of midgut volvulus in the newborn and in the elderly patient with partial ileac resection for mesenteric venous thrombosis. Under such circumstances, it is suggested that the wound splint closure might simplify the re-inspection enough to be life-saving.

As previously reported by Howes and Harvey[5] in several tissues and by Fast, Nelson, and Dennis[4] in the abdominal wall of the rabbit, most (80 percent) of the ultimately achieved tensile strength across the wound is gained in the first 15 days. The occasional unexpected failure of a normal pace of strength gain has led us to delay suture removal until 18 to 21 days, particularly in instances in which poor healing had already been demonstrated.

*Swedged-on trocar needle 0.016 inch steel sutures are to be made available by Ethicon, Inc., Atherton, Calif. 94026.

†Kindly manufactured and provided by Dr. Leonard Kurtz of the Deknatel Company. Splints are to be made available by the Pilling Co., Philadelphia, Pa.

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